Citrix XenDesktop on XenServer and IBM Hardware

Sizing Baseline and Reference Configuration

Contents

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Overview

The overall goal of this White paper is to provide sizing baselines for the deployment of Citrix XenDesktop on IBM BladeCenter Servers running Citrix XenServer.

A laboratory environment was created to test and validate the different components of the IBM hardware and the XenDesktop solution. The main focus of all tests conducted in the laboratory was to define the optimum number of virtual desktops that can be hosted on a single IBM BladeCenter HX5 server.

Reference configuration of the environment, methodology for conducting tests, and the findings from tests performed are presented in this document.

This document assumes that the reader has an architectural understanding of blade server hardware, storage area networks, and the Citrix XenDesktop Platinum components.

Executive Summary

The laboratory environment used for conducting all tests was based on the IBM BladeCenter HX5 Blade Server and the IBM System Storage N5200.

A total of two BladeCenter HX5 servers were used. Each featured dual 1.86GHz Nehalem-EX processors with Intel Hyper-Threading enabled. Both servers were equipped with 50GB solid state drives (SSD), dual port Gigabit NICs, and Qlogic Fiber Channel adapters. Memory configurations included 64GB of DDR3 RAM for the blade hosting virtual infrastructure servers and 128GB for the blade hosting the virtual desktops.

The IBM System Storage N5200 featured a cluster of two controllers and the IBM EXN4000 disk expansion unit with 14 FC 15K HDDs. The N5200 was attached to the HX5 Blade servers via 2Gbit Fiber Channel.

The latest release of the Citrix XenDesktop 5 components available at the time of testing were used to build the laboratory virtual desktop infrastructure. The XenDesktop 5 Site consisted of:

- Two (2) Desktop Delivery Controllers for brokering and managing the virtual desktops,
- Two (2) Provisioning Servers for OS provisioning.

Citrix Licensing and Web Interface servers were also deployed as part of the environment. All of the XenDesktop 5 infrastructure servers were virtualized on XenServer 5.6 FP1.

Tests conducted within the laboratory environment validated the Citrix XenDesktop 5 hosted VDI solution running on the XenServer platform with IBM BladeCenter HX5 servers. Single server scalability tests show a single IBM BladeCenter HX5 server being capable of supporting an optimum number of 80 virtual desktops with a "medium user" workload using Microsoft Office 2010 on Microsoft Windows 7 Professional.

Memory utilization was determined to be the main bottleneck limiting the server from effectively hosting additional desktops with the XenServer virtual desktop host reporting 98% of RAM utilization with 80 active desktops.

A combination of tools was used to simulate user load, monitor resource utilization, and gather data in order to validate the reference configuration. The latest version of the Login Virtual Session Indexer (VSI) 3 from Login Consultants was used for load testing and capturing system response time data. Other tools used for benchmarking and monitoring the environment included Citrix XenCenter, Citrix VM Performance Utility, Windows Performance Monitor, and NetApp's ONTAP.

Reference Architecture

This section details the various components used in the laboratory to configure the environment. Configurations and specifications of the hardware infrastructure, XenDesktop 5, and LoginVSI components is presented in the following subsections. This configuration is only provided for reference purposes; specific configurations for production environments will vary based on each implementation's needs.

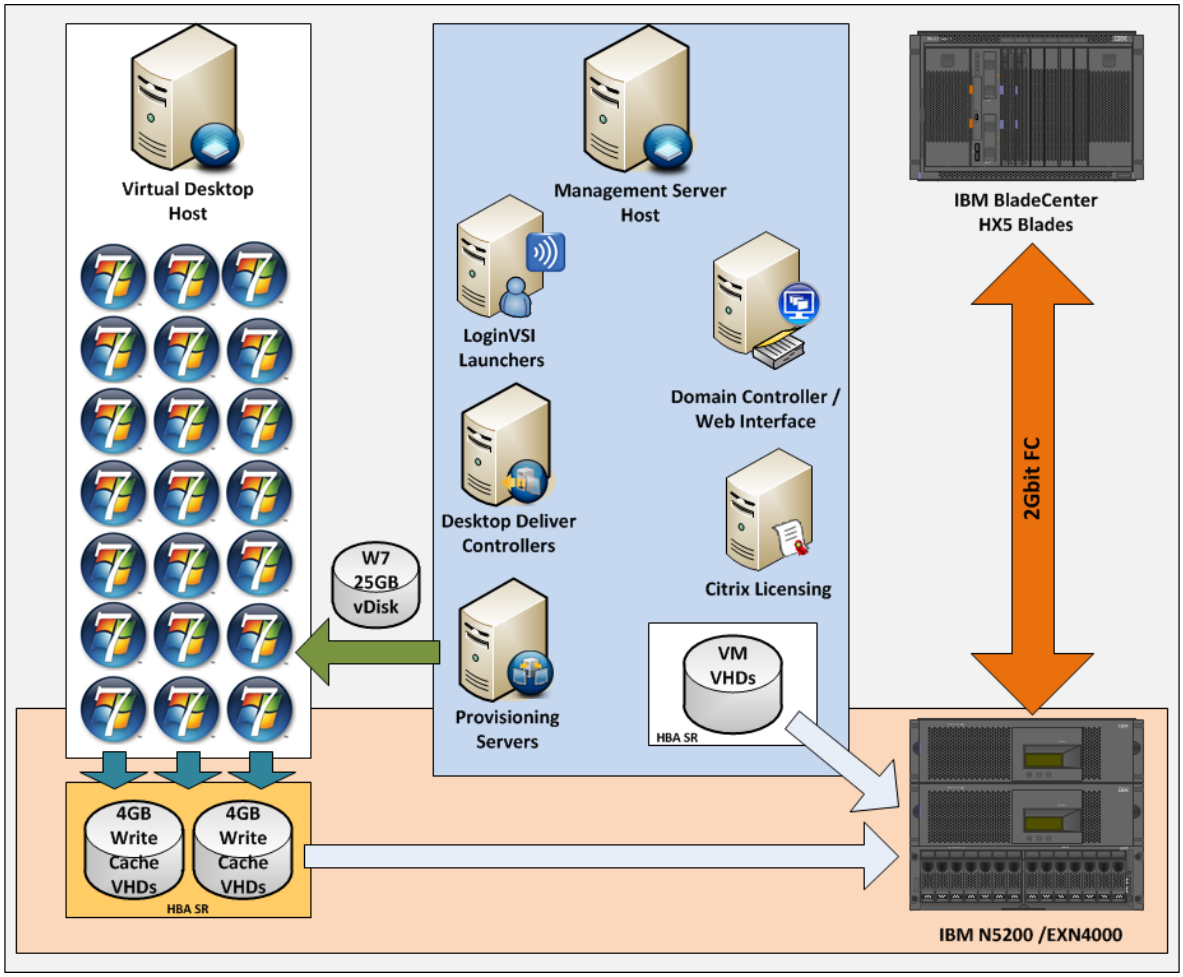


Figure 1 – Laboratory Components

Environment Summary:	
2 XenServer Hosts	Hosting of infrastructure VMs and virtual desktops
2 Desktop Deliver Controllers	Brokering and managing virtual desktops
2 Provisioning Servers	Virtual desktop OS provisioning
1 Citrix Web Interface / AD Domain Controller	Provides access to XenDesktop resources and directory services
1 Citrix Licensing Server	Licensing for all XenDesktop components
5 LoginVSI Launchers	Initiates user sessions

Table 1

Hardware Infrastructure Components

All hardware used to build the laboratory environment was provided by IBM. The environment consisted of IBM BladeCenter HX5 servers and N Series System Storage.

The blade chassis provided was the IBM BladeCenter S equipped with Ethernet and Fiber Channel switch modules. Installed on the chassis were two BladeCenter HX5 blade servers: one for hosting infrastructure servers and the other for the hosting of virtual desktops. Each server was configured with dual Intel Nehalem-EX processors, DDR3 VLP RAM, Solid State Drives, Qlogic Fiber Channel adapters, and onboard Broadcom network interface cards.

Storage was provisioned by IBM System Storage N5200 controllers and the EXN4000 disk expansion unit connected to the servers via Fiber Channel. The aggregate used for the test environment consisted of six FC 15K 300 GB disks in a RAID 4 configuration. This provided the best performance and capacity combination based on the amount of disks available and the requirements of the environment.

Additional details of the configuration of all hardware components used is presented tables 2 – 4 below.

Figure 2 - IBM BladeCenter S

Component	*LAB Configuration*
IBM BladeCenter S	Two BladeCenter HX5 Blades Four power supply modules Four cooling modules One management module One BNT Layer 2/3 Copper Gigabit Ethernet Switch Module One Brocade 8Gigabit Fiber Channel Switch Module

Table 2

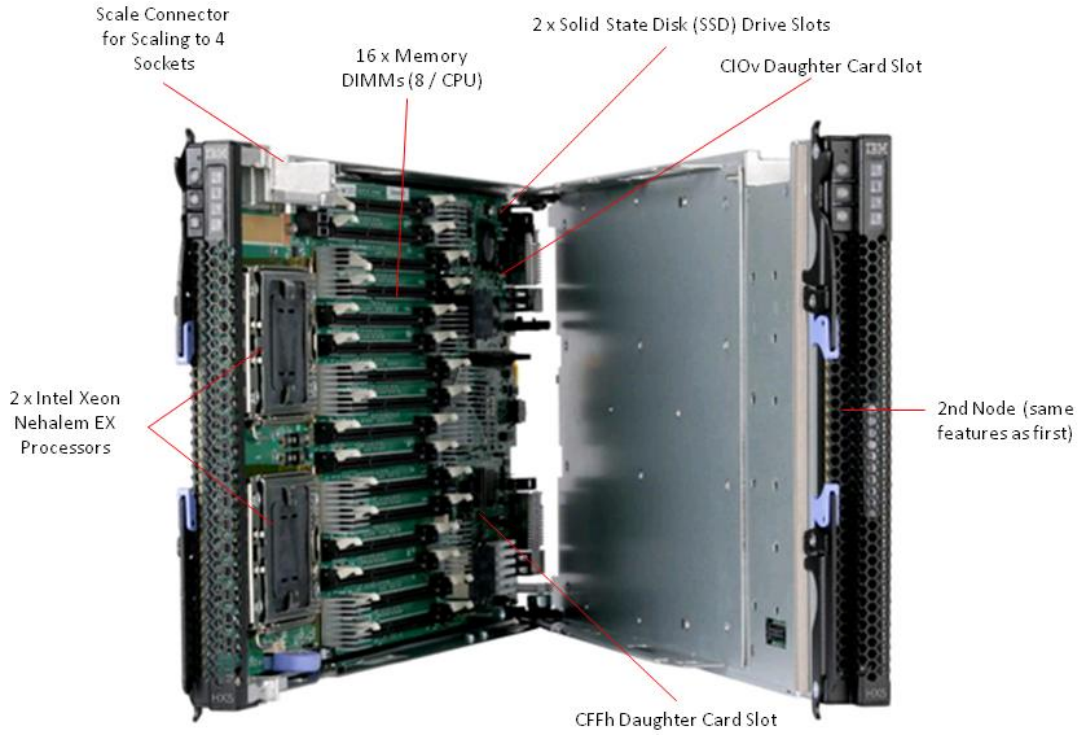


Figure 3 - IBM BladeCenter HX5

Component	*LAB Configuration*
IBM BladeCenter HX5	**XenServer Virtual Desktop Host** ▪ Two Intel Xeon Processors L7555 ▪ Intel Hyper-Threading Technology enabled ▪ 128 GB RAM (16 x 8GB DDR3 SDRAM) ▪ 50GB SSD Drive (SATA 1.5GB) ▪ Broadcom 5709S onboard NIC with dual Gigabit Ethernet ports ▪ Qlogic 8Gb Fiber Channel Expansion Car
IBM BladeCenter HX5	**XenServer Management Server Host** ▪ Two Intel Xeon Processors L7555 ▪ Intel Hyper-Threading Technology enabled ▪ 64 GB RAM (16 x 4GB DDR3 SDRAM) ▪ 50GB SSD Drive (SATA 1.5GB) ▪ Broadcom 5709S onboard NIC with dual Gigabit Ethernet ports ▪ Qlogic 8Gb Fiber Channel Expansion Card

Table 3

Figure 4 - IBM N5200

Figure – 5 IBM EXN4000

Component	*LAB Configuration*
IBM System Storage N Series	N5200 (2864-A20) Modular Disk Storage System Dual Controller Active/Active Configuration DATA ONTAP 7.3.4 2 x Intel Xeon @ 2.8 GHz 4 GB RAM 1 GB Nonvolatile Memory 8 x 2Gb Fiber Channel Ports 8 x 1Gb Ethernet Ports
Disk Expansion Unit	EXN4000 4 x 2/4Gb Fiber Channel Ports 14 x 300 GB 15K RPM FC Disk Drives

Table 4

XenDesktop 5 Components

The XenDesktop 5 solution included the XenServer Hypervisor, XenDesktop Desktop Delivery Controllers (DDC), Provisioning Servers (PVS), Citrix Web Interface and License servers.

All of the XenDesktop infrastructure servers were virtualized on XenServer. With a proper design and best practices applied none of these components require the use of physical servers.

Both the XenDesktop DDCs and Provisioning Servers where deployed in pairs to provide redundancy and high availability. No performance gains from load balancing were expected as a single instance of either of these components could adequately handle the load from the single server scalability tests.

XenServer Hosts

Two XenServer hosts where deployed, each dedicated to a particular function; the management server host was used for all infrastructure servers, and the virtual desktop host was used for all virtual desktops. XenServer 5.6 FP1, the latest release at the time of testing, was used for both hosts.

> **NOTE:** It was necessary to enable "Remote Console" under Console Redirection Settings in the BladeCenter HX5 server BIOS in order to install XenServer 5.6 FP1. Not doing so resulted in the Installation process hanging.

For the installation of XenServer, the locally attached solid state drives (SSD) of the host were used. While XenServer 5.6 FP1 supports boot-from-SAN configurations, it was decided to use local storage to simplify configurations and dedicate the storage array to virtual machine disk operations. Storage repositories for virtual machines were created using provisioned LUNs over Hardware HBA.

To handle network traffic a NIC bond was created using the two available NICs on each host. This bond was used for both XenServer management traffic and virtual machine network traffic.

To better handle the number of virtual machines, the amount of RAM assigned to Dom0 on the virtual desktop host was increased to 2.94 GB from the default 752 MB, as recommended by Citrix.

XenDesktop Desktop Delivery Controllers (DDCs)

The laboratory XenDesktop Site consisted of two DDCs. The site's database was configured using the locally installed copy of SQL 2008 Express on the first DDC deployed.

In XenDesktop 5, collections of virtual machines (VMs) or physical computers are managed as a single entity called a catalog. A catalog is a collection of machines of the same type. The machine type defines the type of hosting infrastructure used for desktops and the level of control that users have over their desktop environment.

For the tests conducted in this laboratory, the catalog was created using the streamed machine type. The streamed machine type enables you to deliver desktops to VMs and blade PCs that have been configured to load the operating system over the network leveraging Citrix Provisioning services.

> **NOTE:** For the purpose of this laboratory, Citrix Provisioning Services was used for provisioning all virtual desktops used in tests. Citrix Provisioning Services technology has been validated and proven effective in large scale deployments of XenDesktop. The XenDesktop 5 Machine creation services (MCS) was not used during testing.

As with previous versions, XenDesktop 5 uses desktop groups to allocate virtual desktops to users and groups. A single desktop group was created from the streamed machine catalog for the laboratory tests.

Provisioning Services (PVS)

The Provisioning Services farm consisted of two Provisioning servers. The farm's database was created on the same SQL 2008 Express instance used for the XenDesktop Site.

The farm was configured with a single site and device collection for all target devices. Target devices were created using Provisioning Server's Auto add feature.

A single vDisk store was configured to create the master virtual desktop image (vDisk) that was used for all target devices. For the laboratory tests the store was configured using the local hard disk subsystem of the Provisioning Servers to store the vDisks. This provides the easiest way of implementing vDisk high availability, suitable for environments with few Provisioning servers such as this. The vDisks were manually synchronized between the Provisioning Servers.

Provisioning Services PXE and TFTP services were used to allow the target devices to boot from the network. The environment's DHCP service scope options were configured to provide the target devices with the required information to connect with the Provisioning Servers and obtain their assigned vDisk.

Citrix Web Interface

The Citrix Web Interface 5.4 is included with XenDesktop 5 and it is installed by default on each of the DDCs during the XenDesktop setup wizard. Although both of the DDCs Web Interface sites were functional, they were not used in any of the tests performed.

For testing purposes, version 5.2 of the Web Interface was used in order to match the LoginVSI reference configuration provided by Citrix and described in section 3.4.

Citrix Licensing

The functionality of all the components required that valid licenses specific to each product were available. For the purpose of this laboratory, a XenDesktop Platinum License file was used. This file included individual licensing for each of the components used.

Additional details of the configuration of the XenDesktop components used are presented on table 5 below.

Component	*LAB Configuration*
Management Server Host	XenServer 5.6 FP1 2 x 8 Core Intel L7555 @ 1.86 GHz (32 Logical Cores Total) 64 GB RAM @ 1067 MHz 50 GB SSD Local Storage 550 GB Storage Repository (Hardware HBA) NIC Bond (2 x 1Gb NICs)
Virtual Desktop Host	XenServer 5.6 FP1 2 x 8 Core Intel L7555 @ 1.86 GHz (32 Logical Cores Total) 128 GB RAM @ 1067 MHz 50 GB SSD Local Storage 450 GB Storage Repository (Hardware HBA) NIC Bond (2 x 1Gb NICs)
XenDesktop – Desktop Delivery Controllers (DDC)	Windows Server 2008 R2 Standard Edition XenServer 5.6 VM 2 vCPU 4 GB RAM 24 GB VHD XenDesktop 5 Controller XenDesktop 5 Desktop Studio Citrix Web Interface 5.4 *DDC 1 – SQL 2008 Express (XD and PVS Data Stores)
Provisioning Services / PXE / TFTP	Windows Server 2008 R2 Standard Edition XenServer 5.6 VM 4 vCPU 8 GB RAM 24 GB VHD 30 GB VHD (vDisk Store) Provisioning Server 5.6 SP1

Component	*LAB Configuration*
Citrix Web Interface / Domain Controller / DNS / DHCP	Windows Server 2008 R2 Standard Edition XenServer 5.6 VM 2 vCPU 4 GB RAM 40 GB VHD Citrix Web Interface 5.2
Citrix Licensing Server	Windows Server 2008 R2 Standard Edition XenServer 5.6 VM 1 vCPU 1 GB RAM 24 GB VHD Citrix Licensing Server 11.6.1 XenDesktop Platinum License

Table 5

Virtual Desktops

All of the virtual desktops deployed for testing were based on the Windows 7 Professional operating system. Desktop virtual machines were configured for a normal user workload following Citrix guidelines in "XenDesktop Planning Guide: Hosted VM-Based Resource Allocation." Each virtual desktop was configured 1 vCPU, 1.5GB of RAM, and a 4GB locally attached VHD for write cache. To prepare the master image, a new virtual machine was created on the XenServer virtual desktop host. Windows 7 was installed and updated with all available security patches and updates available from Microsoft. For the purposes of this test all applications required for testing were installed locally, not streamed or hosted.

The following additional configurations were also implemented for increased performance:

- All user profiles for the test user accounts were created locally on the master image according to the "Login VSI 3.0 Admin Guide."
- All Windows 7 optimizations for XenDesktop and Provisioning were configured following the "Windows 7 Optimization Guide" provided by Citrix.
- All virtual desktops were configured with a locally attached VHD for PVS Write Cache
- Following Login Consultants and Citrix recommendations, page file settings were modified to use a fixed size equal to the amount of memory allocated to the virtual machine, and the location of the page file was set to use the locally attached write cache VHD.

The virtual desktop image was then converted to a Provisioning Services vDisk with the use of the PVS Imaging Wizard.

Table 6 below details the configuration used for all virtual desktops.

Component	*LAB Configuration*
Virtual Desktop	Windows 7 Professional Edition with SP1 XenServer 5.6 VM 1 vCPU 1.5 GB RAM 25 GB vDisk 4 GB VHD (Write Cache) MS Office 2010 Professional Plus Virtual Desktop Agent 5.0.0.148 Provisioning Services Target Device 5.6.1 Adobe Flash Player 10 Adobe Reader 9.1 Adobe Shockwave Player 10.2.0.023 Bullzip PDF Printer 6.0.0.865 FreeMind 0.8.1 Java 6 Update 21 GPL Ghostscript Lite 8.64 Kid-Key-Lock 1.2.1.0

Table 6

Login Consultants VSI

Login Consultants VSI is a tool designed for benchmarking Server Based Computing (SBC) and Desktop Virtualization (VDI) solutions including Citrix XenDesktop. The free version, VSI 3.0 Express, was used for all tests performed.

VSI consists of 4 components:

- AD Domain controller for user accounts and standard policies
- A file share for central configuration and logging
- Launcher workstations to initiate the sessions
- Target platform (VDI or SBC) where the user load scripts are installed and performed

Domain user accounts and standard policies were automatically configured using the AD Deployment setup included with VSI 3.0. As part of the setup a new root OU is created, test users are created and GPOs are imported and linked.

The file share and related permissions were configured manually following the "Login VSI 3.0 Admin Guide."

A total of five launchers were deployed with capacity configured for twenty sessions each. The launchers were prepared for integration with XenDesktop following the "Benchmarking Citrix XenDesktop 4 using Login Consultants VSI 2.1" white paper from Citrix. While some of the product versions described on the white paper are different from the versions used in this laboratory, the configurations are still valid.

Table 7 below details the configuration of the VSI Launchers.

Component	*LAB Configuration*
VSI Launcher	Windows Server 2003 R2 32-Bit Standard Edition XenServer 5.6 VM 2 vCPU 2 GB RAM 8 GB VHD Login VSI Launcher 3.0 Login VSI Analyzer 3.0 Citrix Online plug-in 12.1.0.30 Python 2.6.150 Python 2.6 pywin32-214

Table 7

Methodology

All tests were performed using the laboratory environment and reference configuration described on section 3 of this document. All testing concentrated in determining the optimum amount of desktops that could be hosted on a single IBM BladeCenter HX5 server. Testing was done in two stages: pool spin up and user workload. During both stages, data was gathered from the XenServer hypervisor, XenDesktop infrastructure servers, virtual desktops, and storage to analyze for performance and resource utilization.

Tests were performed several times to ensure results were consistent from one test to the next. Once it was determined that results were in fact consistent, a total of three official tests were executed. The highest and lowest scoring tests were then discarded and the remaining test result was selected to present the findings in this document.

Pool Spin Up

The pool spin up stage consisted of the process involved in getting all virtual desktops within the test desktop group available for use from a halted state. In preparation for the test, the desktop group is put on maintenance mode and all hosted virtual desktops are kept on a halted state within the XenServer host. To start the test, maintenance mode is disabled for the test desktop group and all virtual desktops are then started via XenDesktop 5 desktop group power management settings.

As the virtual desktops boot using the provisioned Windows 7 image and register with the Desktop Delivery Controllers, they become available to users. The test is considered complete once all virtual desktops within the test desktop group show as available on the XenDesktop 5 desktop studio management console.

User Workload

The user workload was the most significant stage in validating the XenDesktop 5 solution with the reference configuration included in this document. The test consisted in generating simulated user load and measuring response time of the various tasks performed during the simulation. The process of simulating user load involved all phases of a user session including user logon, work time, and user logoff.

User workload was simulated using the Login Virtual Session Indexer (VSI 3.0) from Login Consultants. VSI is a benchmarking methodology based on the amount of simultaneous sessions that can be run on a single machine running either bare metal or virtualized operating systems. VSI is the standardized benchmark for Server Based Computing (SBC) and Virtual Desktop Infrastructure (VDI) environments and used by key vendors in the desktop virtualization space.

The tool is 100% platform and protocol independent which allows for easy replication of results across most environments. The Express version of the VSI 3.0 tool was selected for all testing performed.

VSI simulates realistic user workloads. The medium workload used for testing simulates an office worker using generic applications like Office, IE (including Flash applets) and Adobe Acrobat Reader. Like real users, the scripted session will leave multiple applications open at the same time. Every session will average about 20% minimal user activity, similar to real world usage.

The medium workload is the only workload available in VSI Express and it is the default workload in VSI. The following list outlines the automated workflow performed by the medium workload:

- This workload emulated a medium workload user using Office 2010, IE 8 and PDF.
- Once a session has been started the medium workload will repeat every 12 minutes.
- During each loop the response time is measured every 2 minutes.
- The medium workload opens up to 5 applications simultaneously.
- The type rate is 160ms for each character.
- Approximately 2 minutes of idle time is included to simulate real-world users.

Each loop will open and use:

- Outlook 2010 - browse 10 messages.
- Internet Explorer - one instance is left open (BBC.co.uk), one instance is browsed to Wired.com, Lonelyplanet.com and heavy flash application gettheglass.com.
- Word 2010 - one instance to measure response time, one instance to review and edit document.
- Bullzip PDF Printer & Acrobat Reader - the Word document is printed and reviewed to PDF.
- Excel 2010 - a very large randomized sheet is opened.
- PowerPoint 2010 - a presentation is reviewed and edited.
- 7-zip - using the command line version the output of the session is zipped.

Sessions were launched at 30 second intervals until the total amount of sessions configured were started. The test was then allowed to run for about 1 hour to allow each session to go through a minimum of 2 loops before logoff.

In addition to the user workload simulated by the Login VSI tool, a virtual desktop was given to a real person for use during testing. This was of great help in getting a feel for what system response time was like during tests.

Monitoring of Solution Components
During all stages of testing data was gathered and analyzed to obtain performance and resource utilization results of the various components involved.

The following set of tools was used to capture and analyze data:

- **Login Consultants VSI 3.0 Express** – For capturing user experience data based on system response time.
- **Citrix XenCenter 5.6 FP1** – For real time performance monitoring of the XenServer host.
- **Windows Performance Monitor** – For monitoring and capturing performance data of the Desktop Deliver Controllers and Provisioning Servers.
- **Netapp DATA ONTAP 7.3.4** – For monitoring and capturing performance data of the SAN.
- **Citrix Virtual Machine Performance Utility (StormVM)** – For Disk I/O performance monitoring of the XenServer host storage repository used for virtual desktop write cache disks.

Findings

This section describes the findings of the tests performed to validate the XenDesktop 5 solution and defines the success criteria for a successful test run. Data from test results is presented in graphs detailing performance and resource utilization of the main components during each of the testing stages.

Tests results show that with the architecture described in section 3 of this document it was possible to run up to eighty (80) Windows 7 virtual desktops with 1.5 GB of RAM on a single IBM BladeCenter HX5 server without scarifying performance and user experience. Pool spin up test results show that all 80 virtual desktops could be started and made available to users in 12 minutes.

The Intel Nehalem-EX processors proved to be highly efficient under this type of load. Test results show average CPU utilization between 20% and 40% with 5 virtual desktops per core.

Windows 7 virtual desktops 1 vCPU 1.5 GB RAM 25GB vDisk 4 GB PVS Write Cache	**XenServer 5.6 FP1**	
	VMs/Host	VMs/Core
IBM BladeCenter HX5 Dual 8 Core (1.86GHz L7555) 128 GB RAM	80	5

Table 8

The factor limiting additional density on the server was available RAM. XenServer reported 98% of total memory utilization when the 80 virtual desktops where active. The BladeCenter HX5 Server available at the time of this writing had a maximum capacity of 128GB of RAM per single-wide blade. However, IBM is set to release a new version of the HX5 which will support up to 256 GB of RAM and Dual 10 Core processors. These additional resources should allow for greater virtual desktop density on a server with the same form factor.

The IBM System Storage N5200 effectively processed all I/O operations requested by the XenServer hosts. Citrix guidelines state that a typical virtual desktop on a working state would generate a load of about 14 IOPS[1] and require 125kB/s of disk throughput. Based on these guidelines, the N5200 was expected to manage a load of approximately 640 (8 x 80) IOPS with 80% being random write operations and 10MB/s (125kB/s x 80) of disk throughput during the user workload stage. Test results show the N5200 handling Fiber Channel Protocol (FCP) OPS in the 500-600 range, and disk throughput near 10MB/s, very close to expectations. Results from additional stress tests conducted, show the N5200 supporting a high of 878 FCP OPS and 75MB/s FCP write throughput.

As expected, none of the XenDesktop components showed significant resource utilization during any of the tests conducted. Critical components such as the Desktop Delivery Controllers and Provisioning Servers have been proven to work under greater loads.

Success Criteria

Success criteria to determine if a test cycle passed or failed was based on the VSI Max score. The Login VSI Max evaluates the user response time during increasing user load. VSI focuses on how many users can run on the system before it saturates.

The operations executed by VSI to simulate user load are designed to measure system response time by completing activities that leverage resources such as CPU, memory, disk, the OS in general, printing and GDI, among others. These operations are specifically short by nature. When such operations are consistently long the system is saturated because of excessive queuing on any kind of resource. As a result, the average response times escalate. This effect is clearly visible to end-users. When such operations consistently consume multiple seconds the user will regard the system as slow and unresponsive.

Response time for all tasks performed during the simulated user workload is measured in milliseconds. The Login VSI 3.0 Express medium workload used for testing has a pre-defined threshold of 4000ms to determine the VSI Max Pass or Fail rating. Tests that resulted in user response times above 4000ms were considered failed.

While the VSI Max score was the single factor considered for the pass or fail of any given test, real user experience was also helpful in validating VSI results. During all tests conducted, a real user was given access to a virtual desktop in the same manner that the VSI Launchers established connections. User feedback regarding system response time was then evaluated and used to confirm the pass or fail rating given by the VSI Max score. While user feedback is a very subjective measure it is generally used in production environments to determine if the system is performing according to expectations.

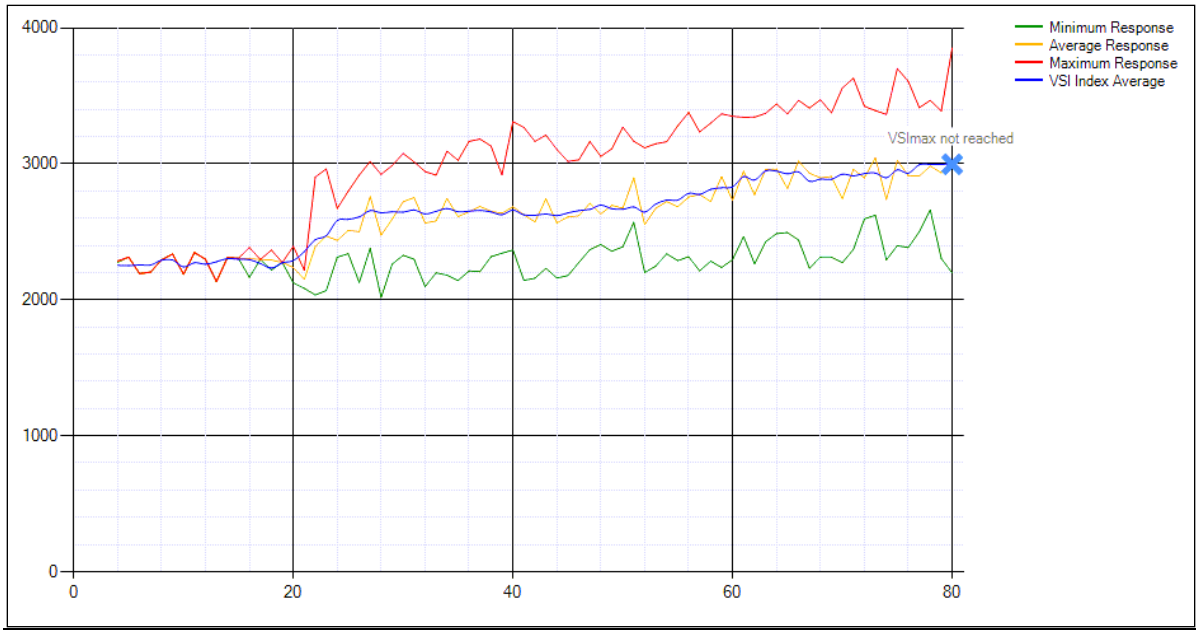
[1] During certain events, such as logon storms, IOPS will be higher than these estimated values.

Test Results

The following graphs demonstrate results from all data gathered during tests. Results from both stages of testing, pool spin up and user workload, are presented for the main components involved.

Login VSI

Graph 1 below demonstrates a successful test run where user experience was not affected by the 80 concurrent sessions running on the same host. All response times are below the 4000ms threshold defined by VSI 3.0 Express.



Graph 1 - Login VSImax / 80 Sessions

Vertical axis: Response Time in milliseconds
Horizontal axis: Total Active Sessions

- Red line: Maximum Response (worst response time of an individual measurement within a single session)
- Orange line: Average Response Time within for each level of active sessions
- Blue line: The VSImax average (Typically VSImax is reached when CPU Utilization is around 100%)
- Green line: Minimum Response (best response time of an individual measurement within a single session)

XenServer

Figure 6 below shows 98% of RAM utilization by the virtual desktop host with 80 active VMs. This was the limiting factor in the amount of virtual desktops that could be hosted on a single server with the specified configuration. Graphs 2 and 3 below demonstrate resource utilization by the virtual desktop host during the Pool Spin Up and User Workload stage. Graph 2 shows cores 0-3 of the host running at about 80%, these cores are used by XenServer and were expected to be highly utilized during the startup of all VMs.

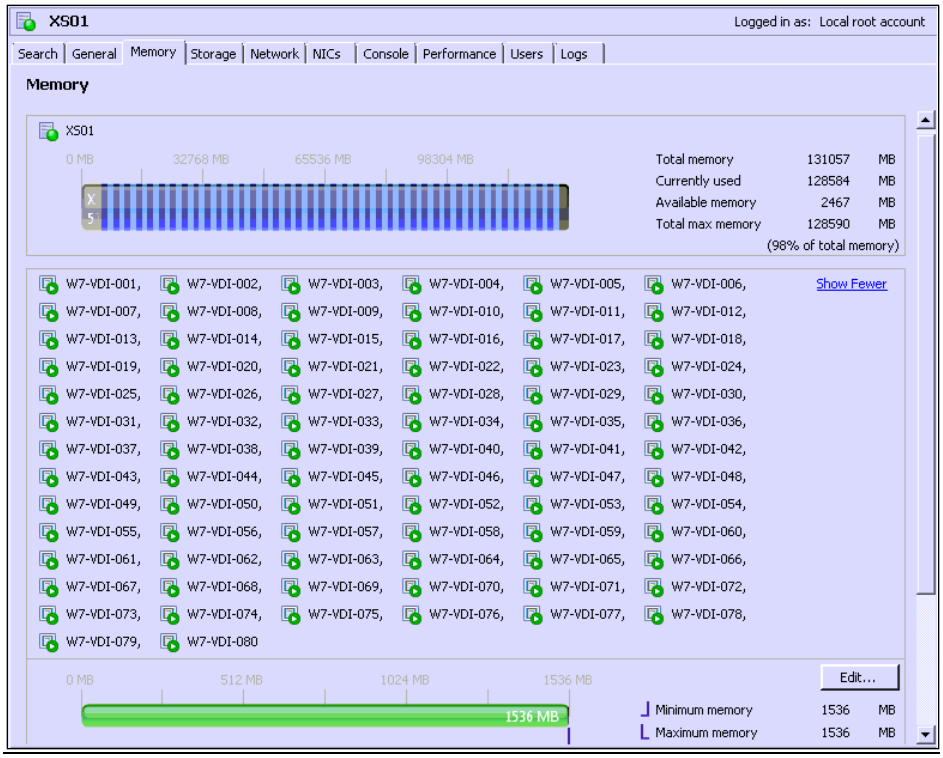
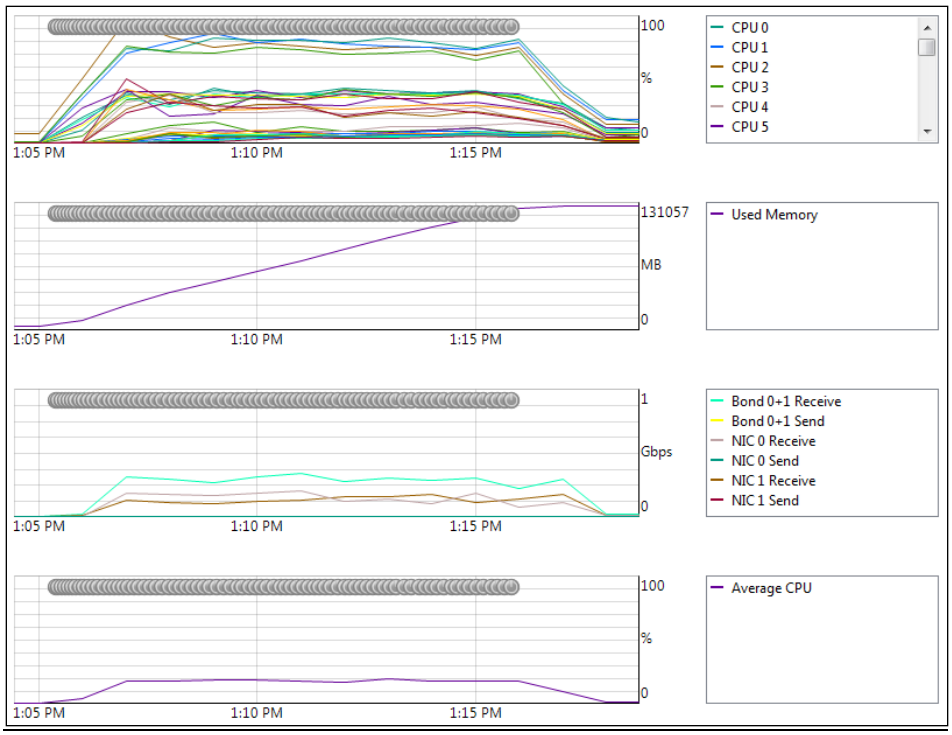
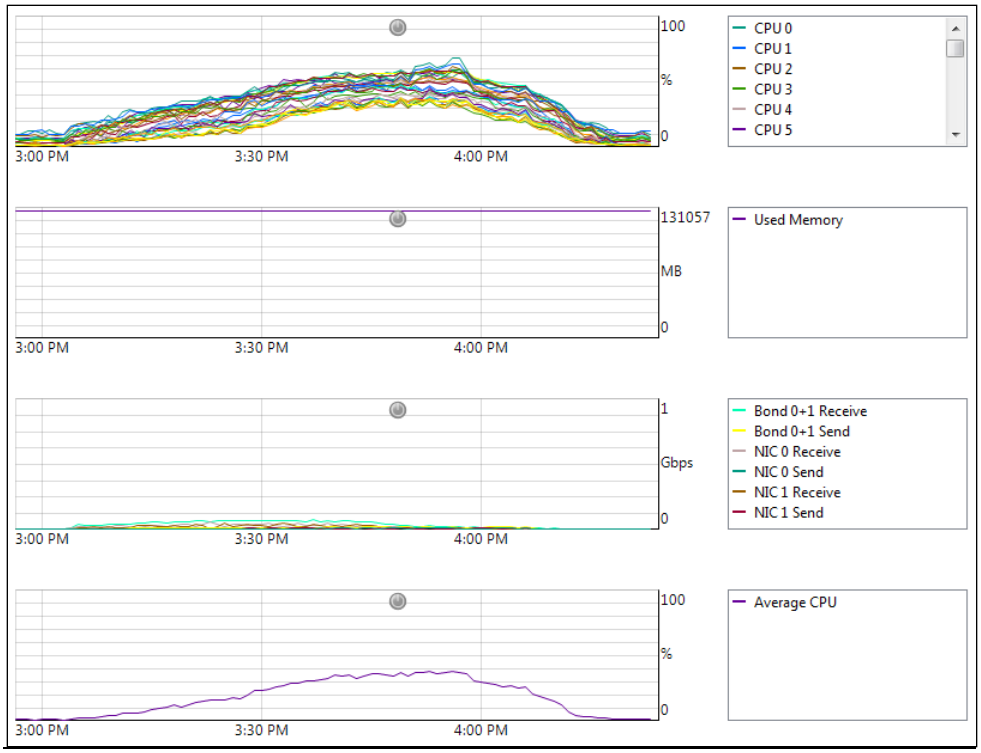


Figure 6 - XenServer Virtual Desktop Host / Memory Utilization



Graph 2 - XenServer Virtual Desktop Host / Pool Spin Up

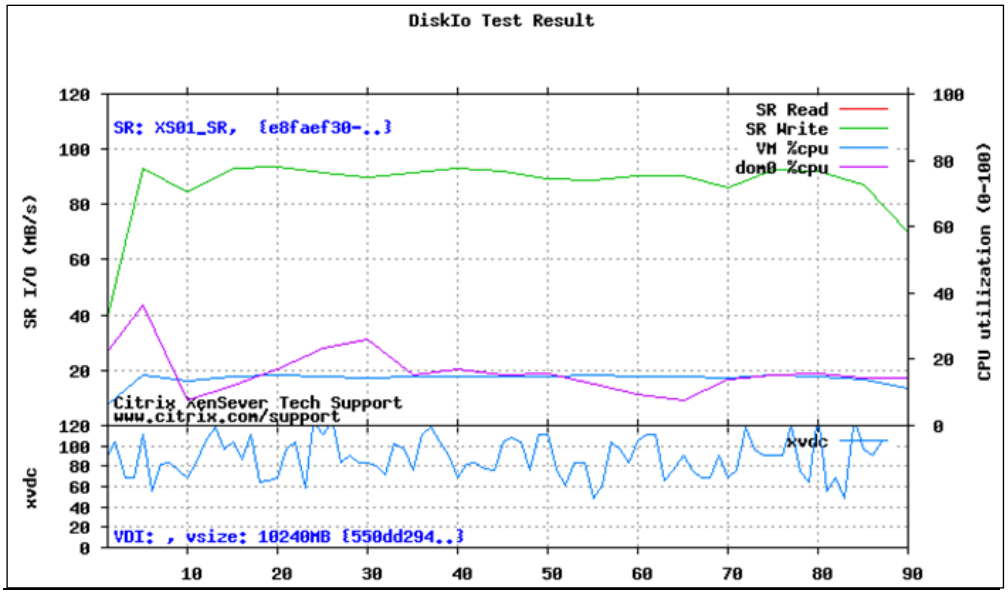


Graph 3 - XenServer Virtual Desktop Host / User Workload

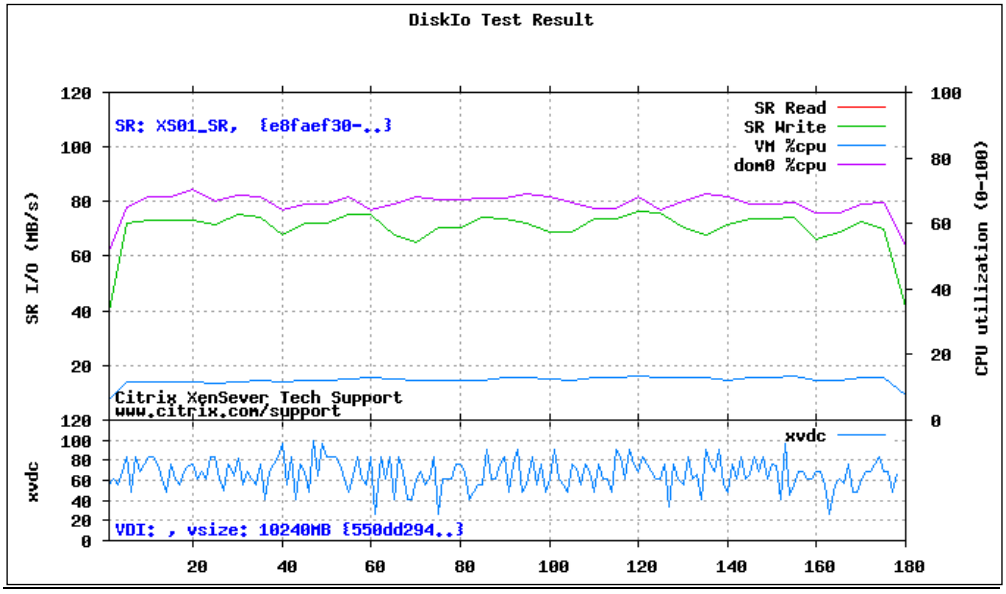
IBM System Storage N5200

The N5200 proved to be more than adequate for a workload of 80 virtual desktops. Test data confirms that write operations account for approximately 80% of the total IOPS generated by VDIs.

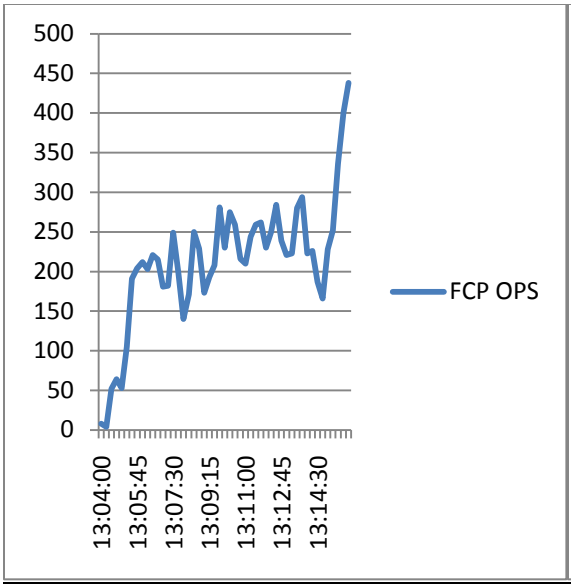
Graphs 4 and 5 below present results from the XenServer Virtual Machine Performance Utility (StormVM) disk I/O benchmark. The StormVM Disk I/O utility was used to conduct a stress test consisting of random write operations on the storage repository used for virtual desktop write cache. The stress test was conducted with virtual desktops being idle and during the user workload stage. The two spikes seen in graphs 7, 9, 11, and 13 represent the impact of the stress test performed during the user workload stage.



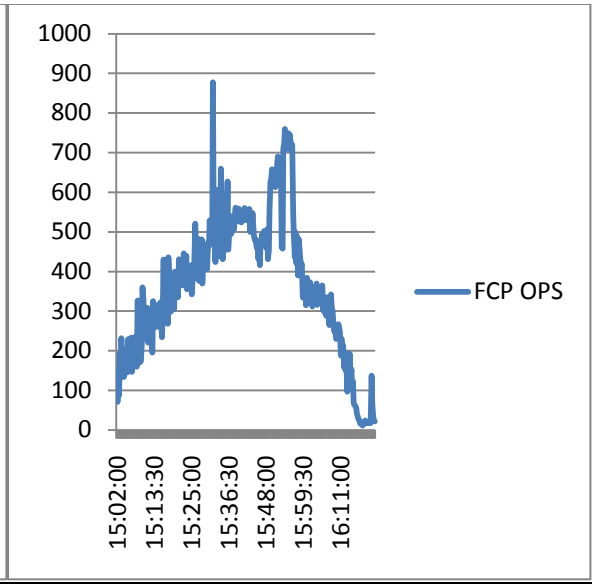
Graph 4 - StormVM 1MB Random Writes / 80 Desktops IDLE



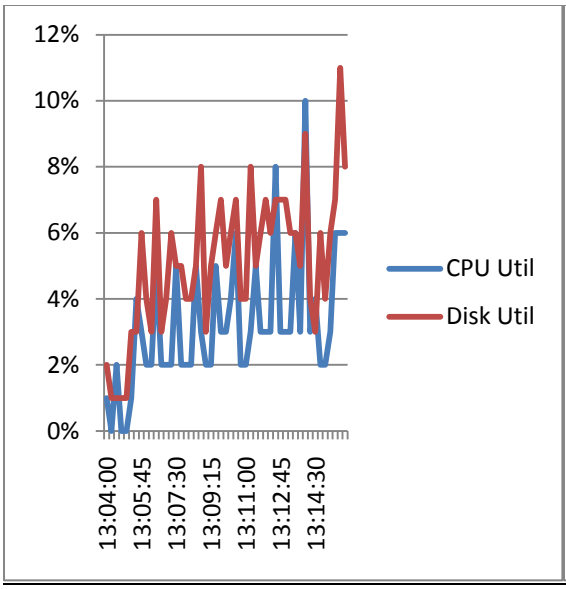
Graph 5 - StormVM 1MB Random Writes / 80 Desktops Active



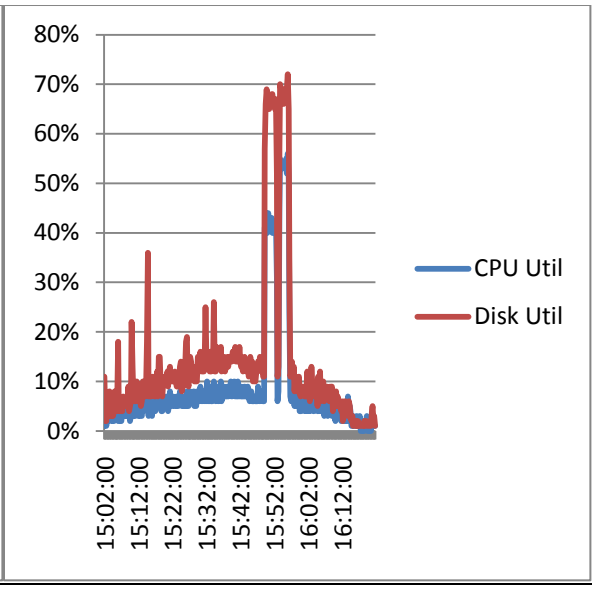
Graph 6 - Pool Spin UP / N5200 FCP OPS



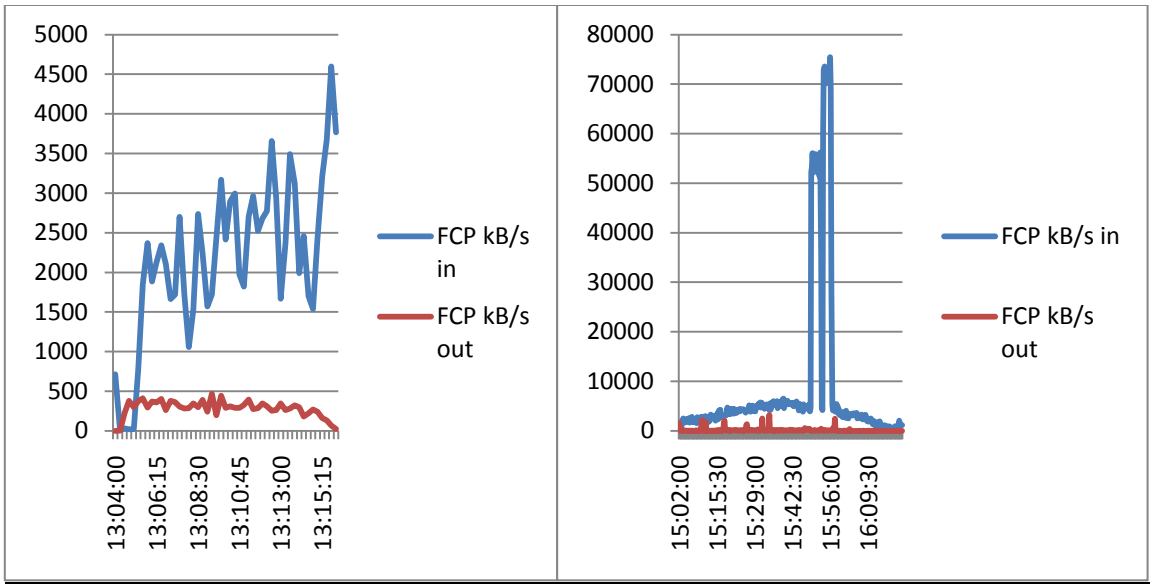
Graph 7 – User Workload / N5200 FCP OPS



Graph 8 - Pool Spin UP / N5200 CPU-Disk Util

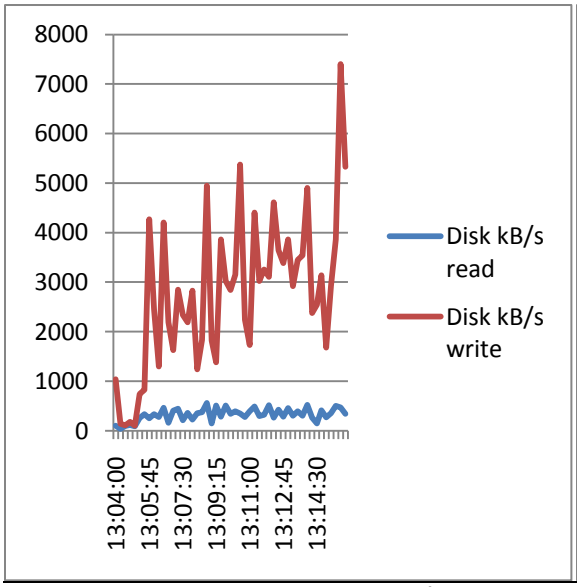


Graph 9 – User Workload / N5200 CPU-Disk Util

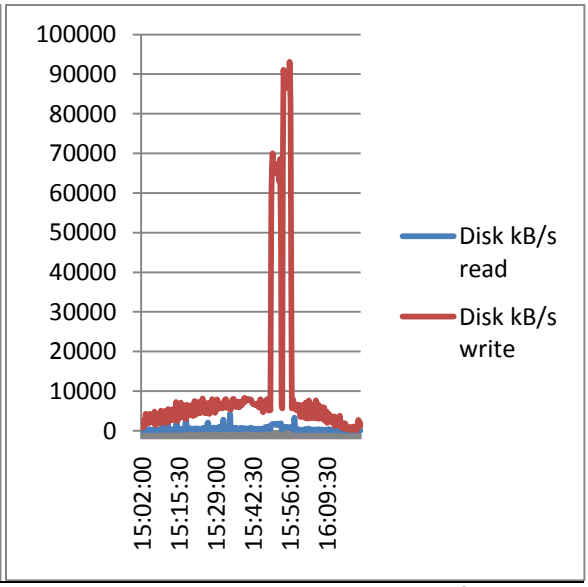


Graph 10 - Pool Spin UP / N5200 FCP Throughput

Graph 11 – User Workload / N5200 FCP Throughput



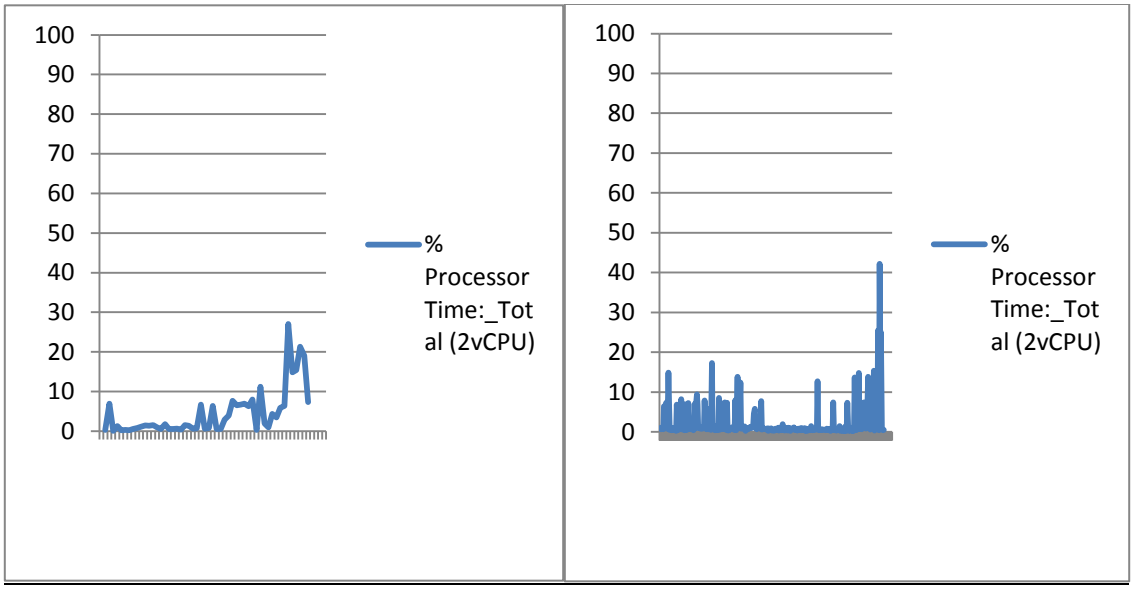
Graph 12 - Pool Spin UP / N5200 Disk R/W



Graph 13 – User Workload / N5200 Disk R/W

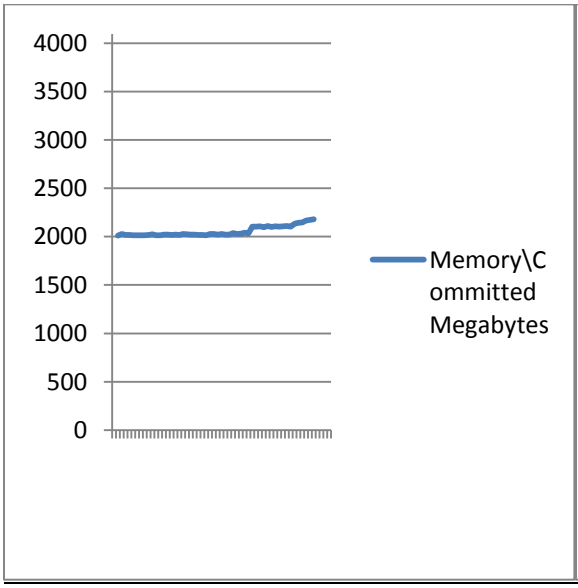
Desktop Delivery Controller

As both DDCs test results were nearly identical, only the data from DDC1 is presented in this document. Data shows DDC resource utilization was very similar during both tests.

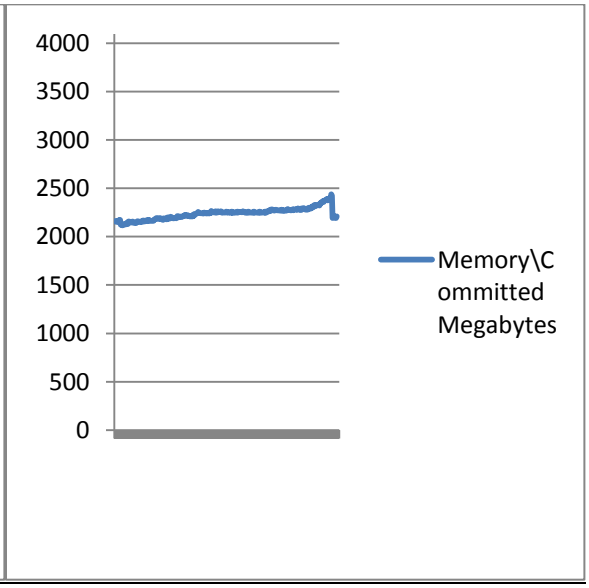


Graph 14 - Pool Spin UP / DDC1 CPU

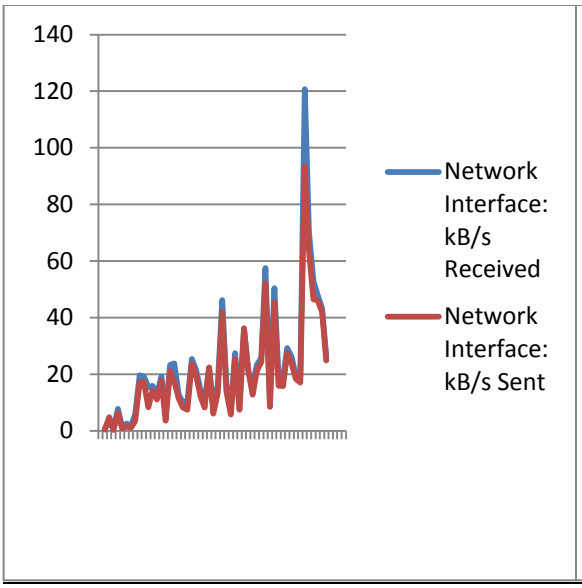
Graph 15 – User Workload / DDC1 CPU



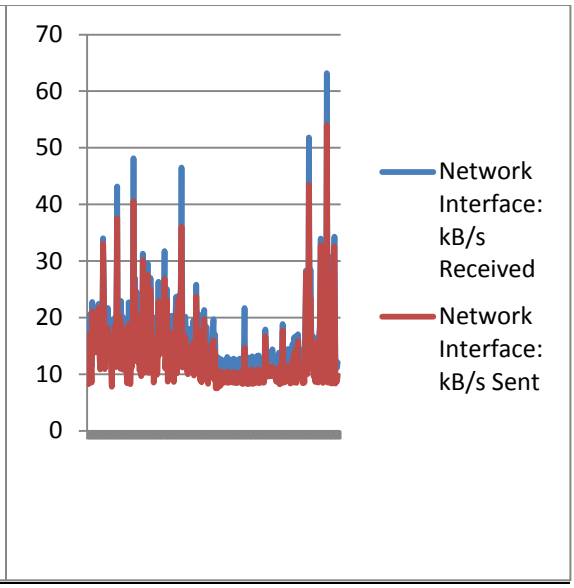
Graph 16 - Pool Spin UP / DDC1 RAM



Graph 17 – User Workload / DDC 1 RAM



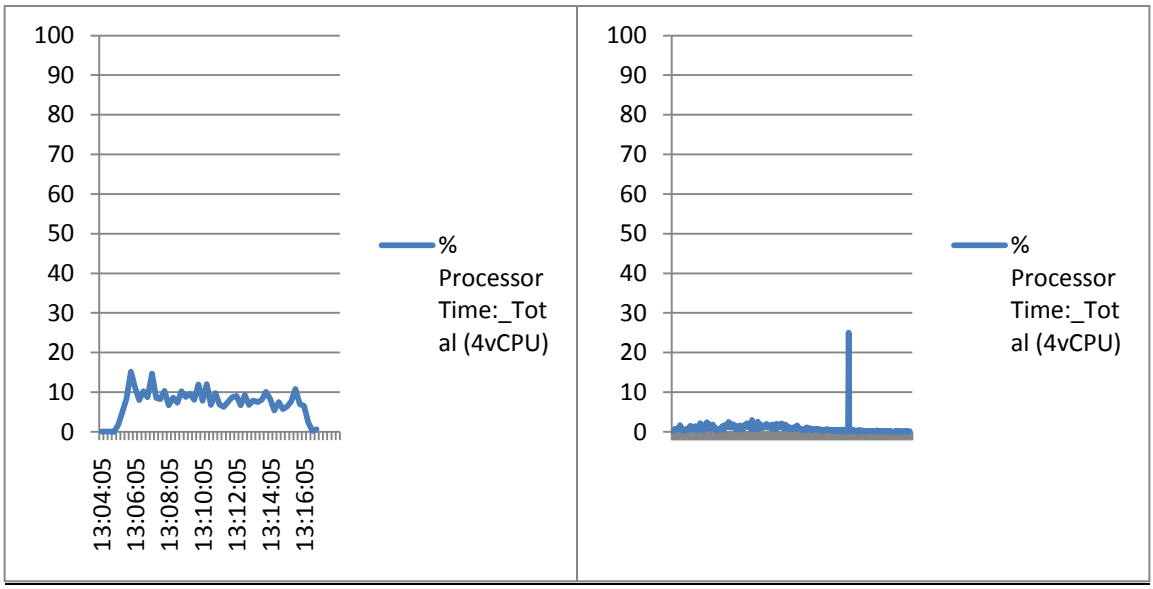
Graph 18 - Pool Spin UP / DDC1 Network



Graph 19 - User Workload / DDC1 Network

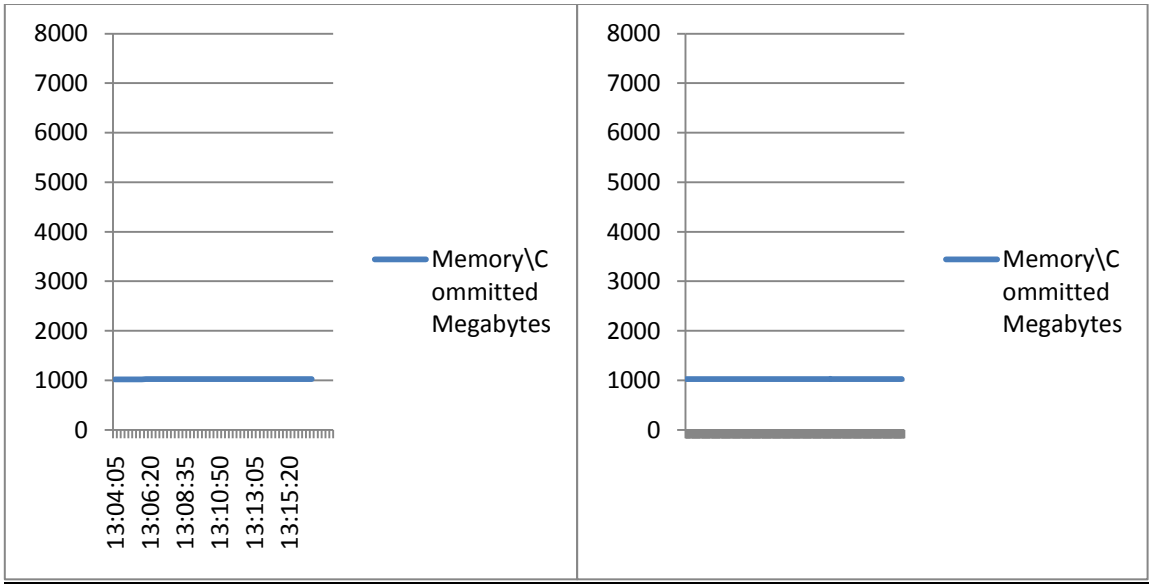
Provisioning Server

As both PVS test results were nearly identical, only the data from PVS1 is presented in this document. As expected, the Provisioning server CPU and network utilization (Graph 20, 24) was the highest during the Pool Spin UP test. Grpahs 22 and 23 show that RAM utilization remained the same throughout both tests indicating the vDisk being cached in system RAM. This is further confirmed on graphs 26 and 27 where disk utilization remained idle nearly 100% of the time during both tests.



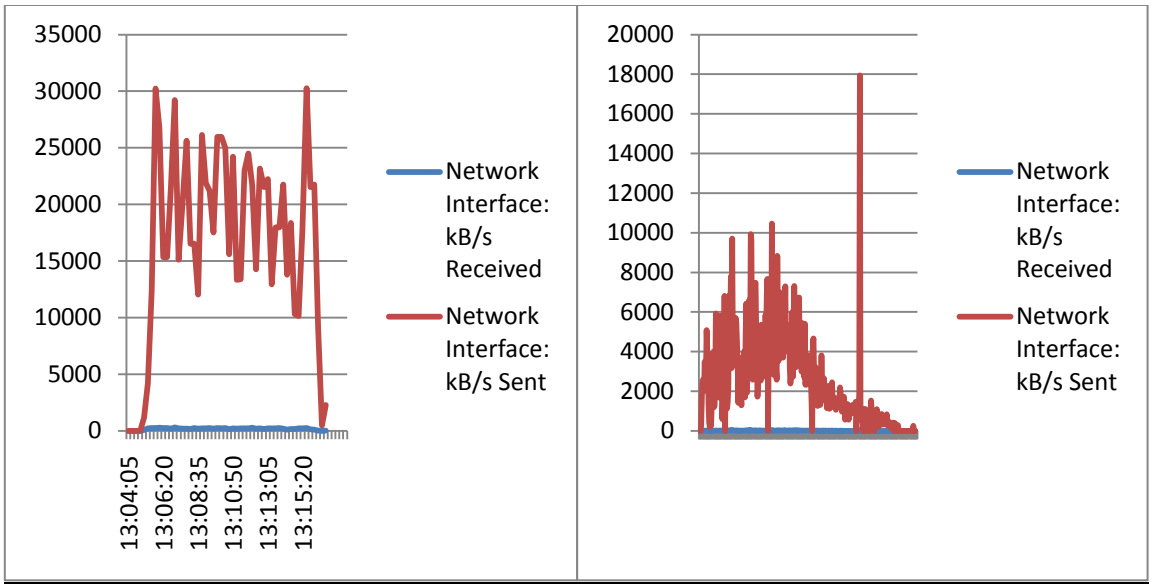
Graph 20 - Pool Spin UP / PVS1 CPU

Graph 21 – User Workload / PVS1 CPU



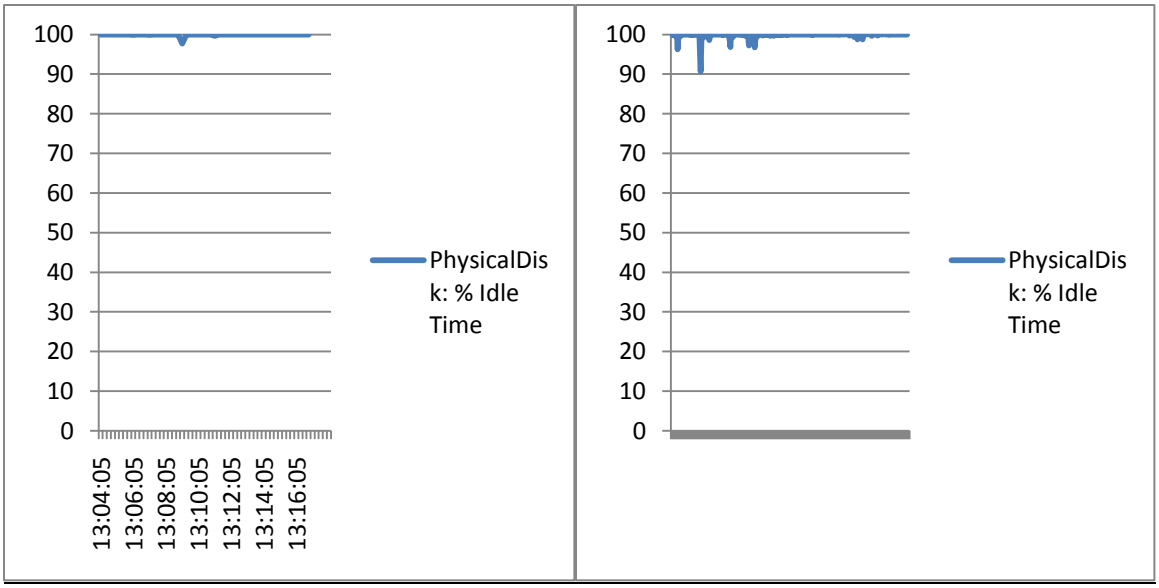
Graph 22 - Pool Spin UP / PVS1 RAM

Graph 23 – User Workload / PVS1 RAM



Graph 24 - Pool Spin UP / PVS1 Network

Graph 25 - User Workload / PVS1 Network



Graph 26 - Pool Spin UP / PVS1 Disk

Graph 27 – User Workload / PVS 1 Disk

References

Reference	*Title*
http://support.citrix.com/article/CTX125630	Citrix XenDesktop with Login Consultants VSI
http://support.citrix.com/article/CTX127050	XenDesktop - Windows 7 Optimization Guide
http://support.citrix.com/article/CTX127277	XenDesktop Planning Guide: Hosted VM-Based Resource Allocation
http://support.citrix.com/article/CTX128645	Design Considerations for Virtualizing Provisioning Services
Included with Login VSI 3.0 Express	LoginVSI 3.0 Admin Guide
http://support.citrix.com/article/ctx127065	XenServer Virtual Machine Performance Utility
http://support.citrix.com/proddocs/index.jsp	Citrix eDocs
http://support.citrix.com/article/CTX126531	Configuring Dom0 Memory in XenServer 5.6

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